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MEMORANDUM FOR PRS (Contractor/In-House Publication)

FROM: PROI (STINFO) 10 January 2002

SUBJECT: Authorization for Release of Technical Information, Control Number: **AFRL-PR-ED-TP-2002-006**
Jeff Muss (Sierra); Curtis Johnson (Sierra); Richard Cohn; Peter Strakey; Ron Bates; Doug Talley,
"Swirl Coaxial Injector Development, Part I: Test Results"

JANNAF JPC **(Statement A)**
(Destin, FL, 8-12 April 2002) **(Deadline: 15 Feb 2002)**

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PHILIP A. KESSEL Date
Technical Advisor
Space and Missile Propulsion Division

Swirl Coaxial Injector Development
Part I Test Results

Jeff Muss and Curtis Johnson, Sierra Engineering, Inc.
Richard Cohn, Peter Strakey, Ron Bates, and Doug Talley, AFRL

Abstract

Injector design is crucial to obtain long life and provide high energy release efficiency in the main combustion chamber. Introducing a swirl component in the injector flow can enhance the propellant mixing and thus improve engine performance. Therefore, swirl coaxial injectors show promise for the next generation of high performance staged combustion rocket engines utilizing hydrocarbon fuels. These injectors swirl liquid fuel around a gaseous oxygen core. This work develops a design methodology, utilizing both high-pressure cold-flow testing and uni-element hot-fire testing to create a high performing, long life swirl coaxial injector for multi-element combustor use. Several swirl coax injector configurations were designed and fabricated by Sierra Engineering, and tested at the Propulsion Directorate of the Air Force Research Lab. Both cold-flow and hot-fire tests were conducted. Cold-flow testing used near-field shadowgraphs and patternation to investigate atomization, non-combusting mixing efficiency, and flow uniformity. The cold-flow results (Figures 1 and 2) allowed ranking injector performance in terms of pressure drop, drop size, spray uniformity, and mixing. The most promising injectors were then installed in a combustor and hot-fire tested. The hot-fire tests demonstrated uni-element performance, ignition characteristics, and some stability characteristics. In addition, the injector elements have been operated at several different mixture ratios to characterize off-design performance. Work in progress (to be completed before the conference) includes flame imaging to better understand flame holding characteristics, and near field combustion phenomena of these swirler elements. The results of the cold-flow and hot-fire tests were compared to discern what phenomena observed during cold flow testing is directly applicable to hot-fire operation.

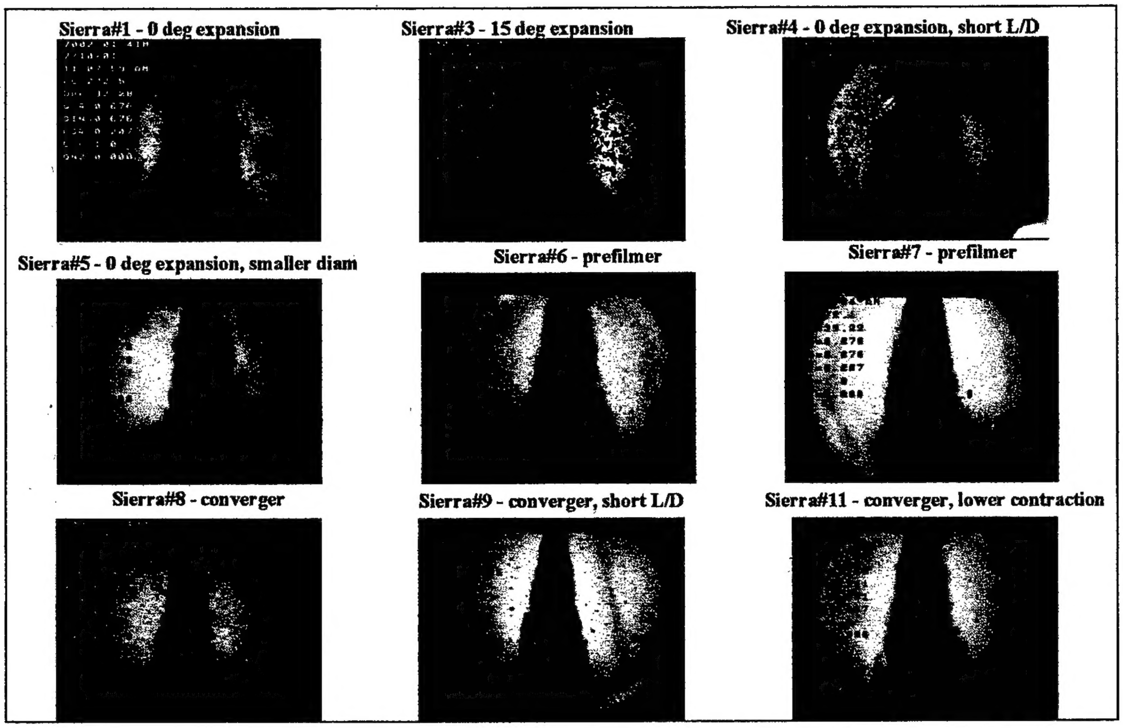

Figure 1. Near-Field Shadow Graphs of Nine Injectors Operating at Pc=285 psia

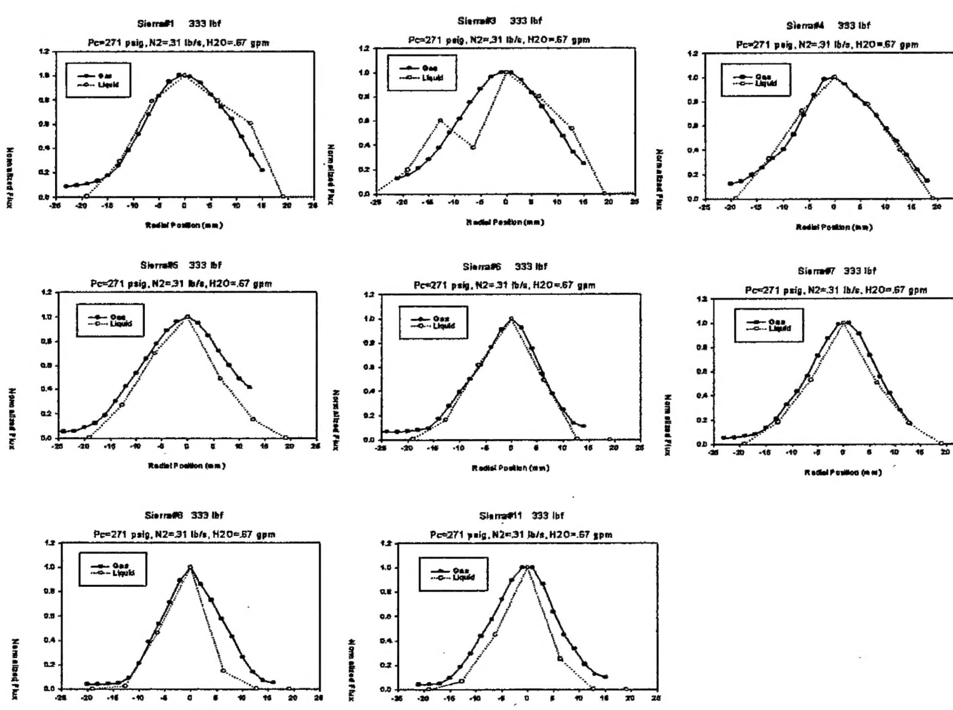

Figure 2. Plots of Liquid and Gas Fluxes 2 inches Below the Injector for Injectors Operating at Pc=285 psia